

CLAIMS

What is claimed is:

1. A nanocomposite surgical material comprising:
 - (a) a polymer matrix; and
 - 5 (b) nanoencapsulated solid filler dispersed within the polymer matrix to produce a composite surgical material having an average matrix ligament thickness of less than about 1000 nanometers.
2. The nanocomposite surgical material of Claim 1 wherein the average matrix ligament thickness is less than 750 nanometers.
- 10 3. The nanocomposite surgical material of Claim 1 wherein the average matrix ligament thickness is less than 500 nanometers.
4. The nanocomposite surgical material of Claim 1 wherein the average matrix ligament thickness is less than 300 nanometers.
5. The nanocomposite surgical material of Claim 1 wherein the polymer matrix is
15 non-biodegradable.
6. The nanocomposite surgical material of Claim 5 wherein the polymer matrix includes an acrylic polymer.
7. The nanocomposite surgical material of Claim 1 wherein the polymer matrix is formed by polymerizing a pre-polymerized polymer component and a monomer.
- 20 8. The nanocomposite surgical material of Claim 7 wherein the pre-polymerized

polymer component is poly(methyl methacrylate), poly(methyl methacrylate-co-styrene) or any combination thereof, and the monomer is methyl methacrylate.

9. The nanocomposite surgical material of Claim 1 wherein the nanocomposite surgical material is in the form of a pre-polymerized surgical implant.
- 5 10. The nanocomposite surgical material of Claim 1 wherein the polymer matrix is biodegradable.
11. The nanocomposite surgical material of Claim 10 wherein the polymer matrix includes polylactic acid.
12. The nanocomposite surgical material of Claim 10 wherein the polymer matrix
10 includes polyglycolic acid.
13. The nanocomposite surgical cement of Claim 10 wherein the nanocomposite surgical material is in the form of a prepolymerized surgical implant.
14. The nanocomposite surgical material of Claim 1 wherein the nanocomposite surgical material is a surgical cement.
- 15 15. The nanocomposite surgical material of Claim 1 wherein the nanoencapsulated solid filler has radio-opaque properties.
16. The nanocomposite surgical material of Claim 1 wherein the nanoencapsulated solid filler has an average mass diameter which is less than 1000 nanometers.
17. The nanocomposite surgical material of Claim 1 wherein the nanoencapsulated
20 solid filler has an average mass diameter ranging from about 750 nanometers to about 1 nanometer.

18. A nanocomposite surgical material comprising:
- (a) a polymer matrix; and
 - (b) nanoencapsulated solid filler dispersed within the polymer matrix to produce a composite surgical material;
- 5 wherein the nanoencapsulated solid filler has an average mass diameter of less than 1000 nanometers.
19. The nanocomposite surgical material of Claim 18 wherein the nanoencapsulated solid filler has an average mass diameter ranging from about 750 nanometers and about 1 nanometer.
- 10 20. The nanocomposite surgical material of Claim 18 wherein the nanoencapsulated solid filler has radio-opaque properties.
21. A powder for preparing a nanocomposite surgical material comprising a polymer matrix and a nanoencapsulated solid filler having an average mass diameter which is less than 1000 nanometers.
- 15 22. The polymeric powder of Claim 21 wherein the polymer matrix comprises poly(methyl methacrylate), poly(methyl methacrylate-co-styrene) or any combination thereof.
23. A method of forming a nanocomposite surgical material, comprising:
- (a) mixing a nanoencapsulated solid filler with a first precursor of the surgical material under conditions sufficient to uniformly disperse the filler in the first precursor without filler aggregation;
 - (b) combining the mixture of step (a) with a second precursor of the surgical material to form a paste; and
 - (c) curing the paste, thereby forming the nanocomposite surgical material.
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24. The method of claim 23 wherein the first precursor is a powder and the second precursor is a liquid.
25. The method of Claim 23 wherein the first precursor is a pre-polymerized poly(methyl methacrylate) and the second precursor is monomeric methyl methacrylate.
26. The method of Claim 23 wherein the nanoencapsulated solid filler has radio-opaque properties.
27. The method of Claim 23 wherein the nanoencapsulated solid filler has an average mass diameter of less than about 1000 nanometers.
28. The method of Claim 23 wherein step (a) is carried out under vacuum or under an atmosphere other than air.
29. The method of Claim 23 further comprising introducing the nanoencapsulated solid filler and the first precursor into a mixer prior to step (a).
30. The method of Claim 23 wherein the nanoencapsulated solid filler and the first precursor are introduced into the mixer under vacuum or under an atmosphere other than air.
31. The method of Claim 23 wherein step (a) is conducted by mixing using a stirring speed exceeding about 350 rpm.
32. The method of Claim 23 wherein step (a) is conducted by mixing using a stirring speed exceeding about 500 rpm.
33. A method of forming a surgical material, comprising:

- (a) mixing at a stirring speed higher than 350 rpm a nanoencapsulated solid filler with a first precursor of the surgical material;
 - (b) combining the mixture of step (a) with a second precursor of the surgical material to form a paste; and
 - 5 (c) curing the paste, thereby forming the surgical material.
34. A method of forming a composite surgical cement having a matrix ligament thickness of less than about 1000 nanometers and comprising a polymer matrix and a nanoencapsulated solid filler, comprising:
- 10 (a) dispersing the nanoencapsulated solid filler in a liquid and a surfactant to form an emulsion or a suspension; and
 - (b) mixing the emulsion or suspension into a polymer precursor.
35. A method for preventing or eliminating aggregation of nanoencapsulated solid filler when incorporated into a surgical polymeric matrix, comprising mixing the nanoencapsulated solid filler and a polymeric matrix precursor at a stirring speed
- 15 higher than 350 rpm.
36. The method of Claim 37 wherein mixing is performed in the presence of an inert coolant.
37. A nanocomposite surgical material comprising:
- (a) a polymer matrix; and
 - 20 (b) coated radiopaque filler dispersed within the polymer matrix to produce a composite surgical material having an average matrix ligament thickness of less than about 1000 nanometers.